FEBRUARY 26, 1990
CHEMICAL & ENGINEERING

NEWS

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ACS spring meeting in Boston
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DCAT celebrates 100th anniversary
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Analytical instruments

New instruments, personnel training, tighter budgets challenge lab managers
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NEWS
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■ **Montedison chemist is arrested for allegedly stealing and attempting to sell trade secret for economically making fluorochemical lubricants.** **Page 5**

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Cover: Photo courtesy of Perkin-Elmer

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Business

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Final Program

199th ACS national meeting in Boston in April will consist of some 4400 technical papers, a variety of social events, and an exposition. **Page 39**

Cover Story

Analytical labs in the 1990s will need faster, more precise, and less costly analyses while facing tighter budgets and a shortage of trained people to run the labs. **Page 31**

Chemical & Engineering News

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LETTERS

Transfer of funds

SIR: In the late 1930s an organization called the Pennsylvania Chemical Society was formed in Pennsylvania for the purpose of advancing the professional standing of chemists (C&EN, Jan. 10, 1940, page 33). The organization was closely allied to the American Chemical Society, and the membership included many of the leading Pennsylvania chemists of that era. The organization apparently became defunct in the early 1950s.

A few years ago the local Pittsburgh Section became aware of the existence of the Pennsylvania Chemical Society bank account and discovered that the account had escheated to the Commonwealth of Pennsylvania due to inactivity. The account has something in excess of $5000. I was approached in 1989 to try to recover these funds.

We have succeeded in recovering the funds. The purpose of this letter is to notify all interested persons that on April 17, 1990, at 9:30 AM, a petition will be presented in the Orphan's Court Division of the Court of Common Pleas of Allegheny County in Pittsburgh to obtain judicial approval for the transfer of these funds to the ACS Pittsburgh Section to be used for the forthcoming 1992 International Chemical Olympics to be held in Pittsburgh under the auspices of the ACS Pittsburgh Section. If any interested persons wish to object to the transfer of these funds they may present their objections to the court. Those who desire additional information can call J. Philip Bromberg, Attorney at Law, at (412) 471-2470.

J. Philip Bromberg
Pittsburgh

Business with China

SIR: I read with great interest your News Focus article, "China's Chemical Industry is Focus of ACHEMASIA '89" by Joseph Haggin (C&EN, Dec. 4, 1989, page 7).

On page 10 in the discussion of the ACHEMASIA representation, the author incorrectly points out that there were four American representatives. Three additional U.S companies were present during the entire show and were clearly identified as U.S. firms. These were Rainin Instruments, Emeryville, Calif.; Durametallic Seals, Kalamazoo, Mich.; and last, but certainly not least, Swenson Process Equipment Inc., Harvey, Ill. The writer and Tony Chao were present during the entire exhibition, and John Mulligan of WEGO General Trading Co. of New York, who represents us in China, was also present.

It is unfortunate that the U.S. did not initially make a heavier commitment to ACHEMASIA, and it is particularly regrettable that a number of the firms that did plan to attend turned out to be "no shows."

Swenson has been actively pursuing business in China for the past two years, and we have successfully negotiated contracts on six citric acid production facilities. While the Chinese are very tough negotiators, we have found that it is possible to sell successfully against European and Japanese competition. The low value of U.S. currency compared with the yen and deutsche mark at the present time means there is an unusual opportunity for American firms to be successful in world competition.

As long as the American appetite for foreign imports of all kinds remains at its present high level, it is essential for firms who can sell equipment abroad, particularly into Asia, to do so. I think the emphasis on horror stories in the article is somewhat overdone; however, there are significant differences in culture and the work habits in China, and some chemical plants in China leave much to be desired. On the whole, we are happy with our business relations in China and we think China will present a significant export opportunity for American companies for at least the next decade.

Richard C. Bennett
President, Swenson Process Equipment Inc.
Harvey, Ill.

DNA fingerprinting

SIR: John Thornton's report on DNA profiling (C&EN, Nov. 20, 1989, page 18) provided an excellent account of the history of forensic testing, the various tests now available for analysis of body fluids, and the use of DNA analysis in criminal cases and as biological evidence in paternity disputes.

As Thornton noted, DNA profiling is not infallible, and because it is technically demanding, there is a high incidence of human error. Yet, because of its use as evidence in court, the results of DNA

Correction

• Feb. 12, page 37: Gregory W. Ebert, PRF grant (Type B) awardee, is at State University College at Buffalo, not at SUNY, Buffalo.

Polyvinyl Chloride Profitability Starting To Turn Up

Prices of widely used plastic are recovering after falling steadily since mid-1989, paced by resurging demand and inventory rebuilding

Bruce F. Greek, C&EN Houston

Producers of polyvinyl chloride are beginning to smile again as prospects brighten for better times ahead. After prices for the widely used polymer plummeted last year, along with producers' profits, they're turning upward again. Further improving the immediate outlook is the likelihood of increased consumption this year, although by only a modest amount, boosted by strong exports.

Longer term, PVC is expected to maintain its position as the second most widely used plastic (low-density polyethylene is number one). However, it can't maintain that position without the improved profitability necessary for new PVC polymer development and further plant investments.

Another contributing factor, production costs, are under better control than they have been in the past, producers say. For instance, prices of PVC raw materials ethylene and chlorine declined last year, and recent process and product innovation has been accomplished inexpensively, setting the stage for broader product lines at lower cost.

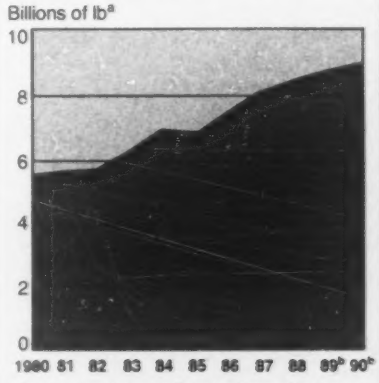
Despite recent price increases of 2 or 3 cents per lb for large-volume grades of PVC, no early return to the selling prices of a year ago is expected anytime soon. During the first half of 1989, selling prices for pipe-grade PVC resins typically were about 45 cents per lb, with other grades selling slightly higher. As ethylene prices began to slump last summer, PVC prices also declined. Late last year, but before the frigid weather along the Gulf Coast in December, pipe-grade resins were down 10 cents per lb or more, or 25% from earlier in the year.

The depressed prices for PVC resulted in major earnings declines in the fourth quarter and for the year for some PVC producers, such as B. F. Goodrich and Vista Chemical.

December's freeze caused damage to PVC production facilities in some areas, cutting five to 10 days' output from total annual production and further reducing inventories that had been falling through the second half of the year. Temporary shortages of some resins occurred suddenly in January, making a potential new round of surplus capacity less troublesome than it had been following the several announcements of capacity expansions in the preceding year.

For now, however, capacity expansions are expected to exceed growth in demand this year, making supplies more than adequate for all but the most specialized PVC resins. These expansions, expected to add 1.5 billion lb to nameplate capacity by the end of this year, will force down average plant operating rates this year and next. Occidental Chemical will complete the first of the 1990 expansions with its 200 million lb-per-year addition scheduled to start up at midyear at Pasadena, Tex. Two other major expansions—800 million lb by Formosa Plastics at Baton Rouge, La., and 500 million lb by Shintech at Freeport, Tex.—are scheduled to begin operating during the second half of the year. With Occidental's 100 million lb of additional output this year and the other two expansions probably adding about 300 million lb, 1990 potential production likely will increase about 400 million lb.

Demand for PVC will grow slightly this year



a Sales and captive use. b Estimate. **Sources:** Data compiled by Ernst & Young for Committee on Resin Statistics of the Society of the Plastics Industry, C&EN estimates

At the start of this year, U.S. PVC nameplate capacity using all the kinds of polymerization processes—suspension, emulsion, bulk (or mass), and solution—totaled about 10 billion lb. Last year, a combination of plant additions and process improvement projects added more than 750 million lb to U.S. capacity.

Of the 9.5 billion lb or so of actual capacity available last year, PVC production totaled about 8.6 billion lb, compared with about 8.4 billion lb in 1988. The average plant operating rate thus was barely more than 90%, down from the previous year's rate of about 95%, when PVC capacity was severely strained to meet demand. The capacity squeeze of 1988 began a yearlong increase in selling prices for PVC.

This year, PVC producers expect their output to increase about 2%. If production ends up totaling 8.8 billion lb or so, and average name-

Construction dominates PVC consumption

Millions of lb	Total sales and use[a]
Calendered products	**769**
Flooring	182
Textiles	100
Other	487
Coated products[b]	**305**
Extrusions	**4299**
Pipe (excluding fittings)	2513
Siding	656
Wire and cable	332
Packaging film and sheet	288
Other	510
Molded products	**439**
Bottles	182
Other	257
Paste process products	**146**
All other	**451**
Exports	**708**
TOTAL	**7119**

a Based on data through October 1989. b Includes flooring, textile and paper coatings, protective coatings, adhesives, and other. **Source:** C&EN estimates from data compiled by Ernst & Young for Committee on Resin Statistics of the Society of the Plastics Industry

plate capacity for the year increases to 10.5 billion lb, the year's operating rate will fall to about 84%.

Although PVC capacity after this year is harder to estimate—partly because some capacity may be shut down in light of its failure to compete economically with more technically advanced processes incorporated in expansions this year—it's clear that unless demand rises 10% or more (which now is very unlikely), operating rates may again decline in the early 1990s.

Meantime, producers' 2% increase in output this year will just match their expectation for a 2% rise in consumption (or slighty more if inventory building of fabricated products becomes significant). All of this growth is likely to come from demand in the U.S., with exports holding at last year's near-record level following a very large increase from 1988. Imports of PVC, at about 40 million lb, have little impact on total supply.

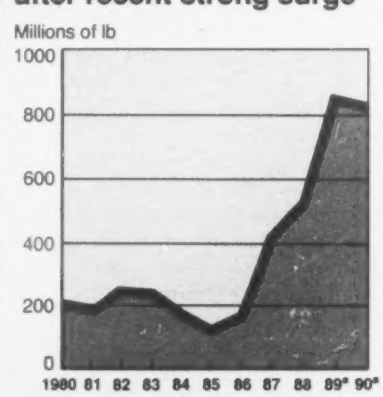
Demand for PVC in the U.S. last year declined more than 3% from 1988 to about 7.7 billion lb, according to Earl H. Simpson, manager of chemical analysis at Bonner & Moore Market Consultants. Much of the decline was in PVC pipe and fittings uses, but wire and cable coverings also contributed.

Total demand would have fallen even more had it not been for the large jump in PVC exports, particularly during the second half of the year. For all of 1989, Simpson estimates PVC exports totaled more than 850 million lb, up 330 million lb, or more than 60%, from 1988. Exports in 1988 also were up a significant 20% from the previous year.

Simpson doesn't expect the booming export market to continue, however, but forecasts a slow decline later in this decade as new PVC capacity comes on stream in other parts of the world, especially in the Far East. Although several of the announced capacity additions are large, their effect on U.S. exports likely will be minor because of construction delays and rapidly increasing demand for PVC in the countries where the plants are to be located.

This year's recovery in domestic demand for PVC will bring consumption back to about the level of 1988, or slightly less than 8 billion lb. The recovery will occur mainly in those uses that declined most in 1989—pipe and fittings, and wire and cable coverings. Use of PVC in siding and accessories, profiles used in windows, and in other residential exterior building products will continue to grow well above average rates. Siding and other residential construction uses were the brightest parts of an otherwise dreary 1989, posting an increase in demand of more than 10%, to more than 800 million lb and becoming the second largest domestic use of PVC, yet well below the pipe market.

Exports of PVC level off after recent strong surge



a Estimate. **Sources:** Data compiled by Ernst & Young for Committee on Resin Statistics of the Society of the Plastics Industry; C&EN estimates

Pipe and fittings, in fact, take more than 40% of U.S. PVC demand, or more than 3.3 billion lb. Last year, this use declined more than 5% as construction of homes and light commercial buildings eased. The fall in demand for PVC going into pipe and fittings exceeded the construction decline. When PVC pipe demand weakened during the usual summer lag before the seasonal slowing of construction, prices weakened, which also was usual. However, an image of too-high finished pipe inventories developed. As a result, not only were inventories of PVC resin grades for pipe reduced, but inventories of pipe also were sold off in anticipation of replacing them with less expensive pipe made with the less expensive PVC. The inventory liquidation grew, causing an annual decline of more than 13% in PVC going into pipe during October 1989.

This year's recovery in PVC demand for pipe and fittings is expected to make up only about 75% of the 1989 decline. Much of the growth is forecast to occur in making large-diameter pipe (typically 15 inches and larger) used mainly in municipal water and wastewater systems. This pipe, which has far greater wall thickness than the smaller sizes used in houses and commercial buildings, vastly increases PVC consumption per linear foot. Municipal construction continues to boost demand for PVC pipe, because cities and other entities are trying to catch up with demand for services and to replace worn out water facilities.

Other than the siding and window components applications of PVC, other uses are forecast to have a lackluster year in 1990. PVC's penetration in many product areas, such as wire and cable coverings, flooring, textile products, film and sheet for both packaging and nonpackaging uses, and bottles, likely has reached its maximum. In these areas, the plastic will do well to hold onto current levels of use. □

Analytical Lab Managers Brace for Challenges of 1990s

Developing new instruments, training enough personnel, and working within tight budgets are among potential problems they face

Joseph Haggin, C&EN Chicago

Changes have been sweeping analytical chemistry laboratories during the past decade and laboratory managers are now taking stock and trying to anticipate what will happen next. Several members of the Analytical Laboratory Managers Association (ALMA) recently examined the immediate future of the analytical lab in the U.S. They suggest that, while changes in instrumentation may not come so rapidly, other problems will severely tax the analytical community.

It is axiomatic that analyses will have to be faster, more accurate, more precise, and less expensive. They will also have to meet new requirements from more government agencies. Simultaneously achieving all these goals requires more than buying better instruments. The care and maintenance of instruments, as well as their organization, optimum operation, and location are equally important. The biggest problem of all may continue to be training enough people to design and operate the laboratories. And the problem of funding also looms, especially for academic R&D.

The "age of instrumentation" didn't begin just a decade or two ago, as some may think. Edward C. Olson, former director of the analytical lab at Upjohn Co., arbitrarily gives the honor to 1922. That's the year, he says, that carries the first reference to instrumentation in *Chemical Abstracts*. Before 1922, chemical instruments were referred to as "apparatus." Today's references are too numerous to count and they reflect the bewildering range of instruments available to the analytical chemist.

Olson suggests that one of the prime driving forces in the future development of analytical chemistry will be biotechnology. In particular, he points to the human genome initiative, now under way, which will "pour hundreds of millions of dollars into mapping the hundred thousand or so genes that have been identified." Far fewer have been adequately characterized. New instrumentation will continue to be needed for this project. Olson also thinks that international cooperation is essential. Every "scientific country" is involved and will have to cooperate to avoid unnecessary duplication.

The cost and duration of the genome initiative have been grossly underestimated in Olson's view. He also thinks relatively few new instrumental techniques will be developed but that massive refinement and proliferation of the present basic instrumentation will occur. Among the new developments he does foresee are truly monochromatic x-ray laser systems and high-intensity x-ray sources. Significant improvements should be made in the computational programs for x-ray structure, maybe even success in developing direct methods for determining macromolecular structure.

Unlike some observers, Olson does not subscribe to the need for ever-higher resolution in mass spectrometry (MS). He opines that most of the high-resolution mass spectrometers he is aware of don't operate anywhere near their maximum capability. He prefers more emphasis on ionization techniques that permit the vaporization of larger molecules.

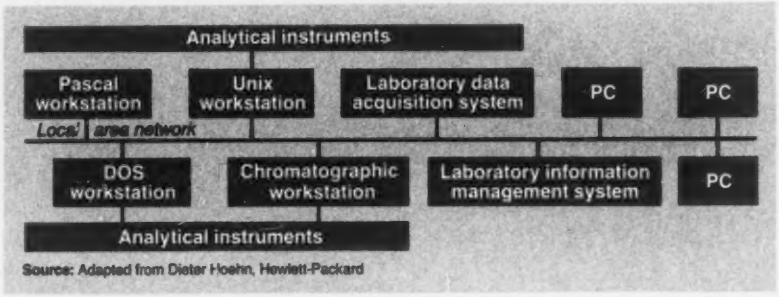
Hewlett-Packard photo

Networked computer system is integral part of modern analytical lab

In the case of nuclear magnetic resonance (NMR) spectrometry, Olson doesn't foresee much immediate change. But he does see a need for greater resolution in electron microscopy, particularly for viewing organic molecules. Also, he suggests that infrared and ultraviolet spectroscopy and other optical methods of analysis have been developed to maturity. The same is true for electrochemical techniques and for gas and liquid chromatography (GC and LC).

Olson thinks that a new kind of organization featuring analytical centers will be used jointly by universities and industry. Cost will dic-

One concept of the unified laboratory



Source: Adapted from Dieter Hoehn, Hewlett-Packard

tate this. "We are now looking at instruments that cost a million dollars each," he says. "Not many organizations can afford multimillion-dollar instruments."

A different industry viewpoint is offered by Richard A. Dreher, president of RAD Associates, a consulting firm specializing in analytical laboratory development. Dreher contrasts the academic and industry views of paying for instrumentation as significant. The academics usually spread the cost of instrumentation over several projects, departments, and so forth. Industry is less inclined to do so. In addition, ever-greater government involvement in the marketing of new products often has made security of the data systems crucial.

Dreher also suggests that the cost of networking will be a bigger budget item in the near future. In addition to the cost of the basic instrument, he says, software, computing, and report generation will add to the cost of operation. Necessary updates in hardware and software will compound the difficulties.

Industry puts great emphasis on productivity, with the biggest impediment at present being the time spent in sample preparation. Dreher considers the automation of sample preparation to be of prime importance.

In the immediate future, Dreher believes that tandem analysis, the sequential integration of several analytical procedures and instruments such as LC/NMR/MS, will become more common. A major impediment to tandem analysis is the lack of standard specifications in the hardware and software, particularly where international markets are involved. He has also discovered that personal computers (PCs) still are not really user-friendly, despite all the publicity to the contrary. He says computers simply don't make instruments easier to operate. Instrument/computer/people interfaces must be made truly friendly before any serious networking can take place, he believes.

Like Olson, Dreher emphasizes the rapidly growing importance of security. The precise time, technique, place, and procedures used in any given analysis will be subject to audits with increasing frequency. Labs have already seen a number of legal struggles that hinged on these audits. They will probably increase in frequency.

The viewpoint of the instrument maker was propounded by Dieter Hoehn, vice president and general manager of Hewlett-Packard Corp.'s Analytical Products Group. Among the principal trends he sees are the emergence of biotechnology, the hyphenated techniques (tandem analysis), distributed computing, and the gradual appearance of expert systems and robotics. He expects genetic engineering to be the driving force for some totally new kinds of instruments.

If Dreher pointed to the yet-to-be-proven friendliness of PCs, Hoehn suggests that PCs have been responsible for the trend toward distributed computing, friendly or not. In any case, the modern analytical lab is growing less dependent on a centralized computing department and offers new room for flexibility in lab design and operation.

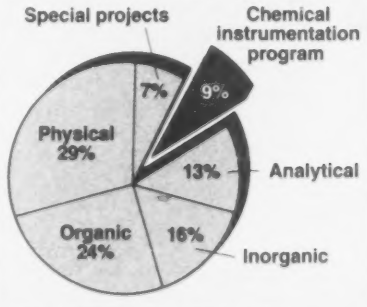
A major milestone in analytical instrumentation has been the emergence of Fourier transform infrared (FTIR) instruments, which were possible because of corresponding major developments in electronic chip manufacture and exponential improvements in machine computing.

The 1960s saw the emergence of individual instruments employing analog signal processing. The 1970s produced smart instruments and microprocessors. In the 1980s, labs moved from individual instruments to digital systems, where the emphasis was on information management. All the developments were driven by labor and computing costs. Computing costs declined about 30% but labor costs increased. At the present time, says Hoehn, the developmental and operational activities of analytical chemists are still driven by the same four considerations of the past three decades: the identity and amount of the analyte and the speed and accurate documentation of the analysis.

Hoehn says that lab managers are already experiencing a shortage of trained people to run the new labs. This shortage will become more acute and will tax their ability to provide and keep people with the necessary skills. Similarly, the sometimes bewildering requirements of environmental legislation make future costs and budgets very hard to estimate.

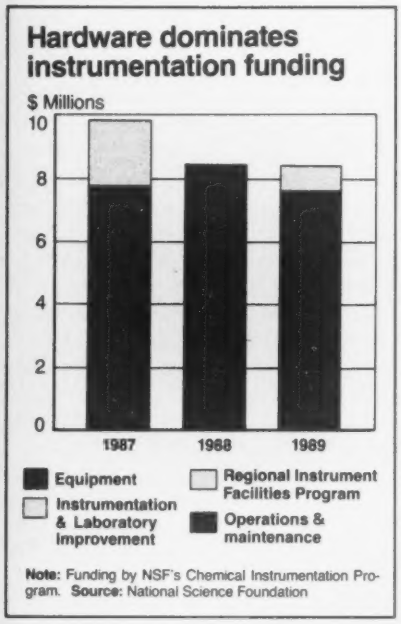
It is now certain, says Hoehn, that no single instrument maker can hope to satisfy all needs, if such ever existed. The broad-spectrum instrument supplier who tried to be all things to all customers is proba-

Instruments took 9% of NSF Chemistry Division budget



Fiscal 1989 total = $98.3 million

Note: Percentages do not total 100% because of one-time allocation to one science and technology center.
Source: National Science Foundation



bly no longer in existence. This trend toward greater specialization brings with it some problems. One is the lack of industry standards at the user interface. As Dreher noted previously, this adversely affects productivity and makes software less than friendly. This also means that the instrument maker must pay more attention to training the user. Training times on new instruments are long, again adding to the productivity bind. The complexity of the systems must be reduced, Hoehn says.

Among the technology trends that Hoehn sees in the near future are smaller instruments (as a result of applying micromechanics) and ever more specific instruments. New detection principles could lead to higher sensitivity, he believes. It's significant, he adds, that the last 10 years have seen a reversal of the former trend of higher cost with higher reliability.

Hoehn expects to see a fundamental change in the industry in the area of sample processing and automation. The norm today is to move the sample into the lab for analysis. In the future, he explains, the sample will not be moved around; instead, data will be sent back and forth as required. Obviously, this will mean great data processing capability.

Hoehn foresees the future analytical chemist being increasingly occupied with his "workstation," a PC-based control center networked to the instruments and other stations of interest. Today, analysts mainly do instrument control data handling at the workstation. Some are already networked but they are usually rather primitive. He believes eventually there will be a global network that includes customers, suppliers, research contractors, and so forth. It will be important to integrate the necessary paperwork into the network, including the electronic laboratory notebook and archive functions. The analyst probably will also be networked into electronic mail and will have available databases for molecular modeling and statistical analyses, as well as personal databases. These workstations will have the computing power of the mainframe of a decade ago and there should be no need to study computer sciences to operate them.

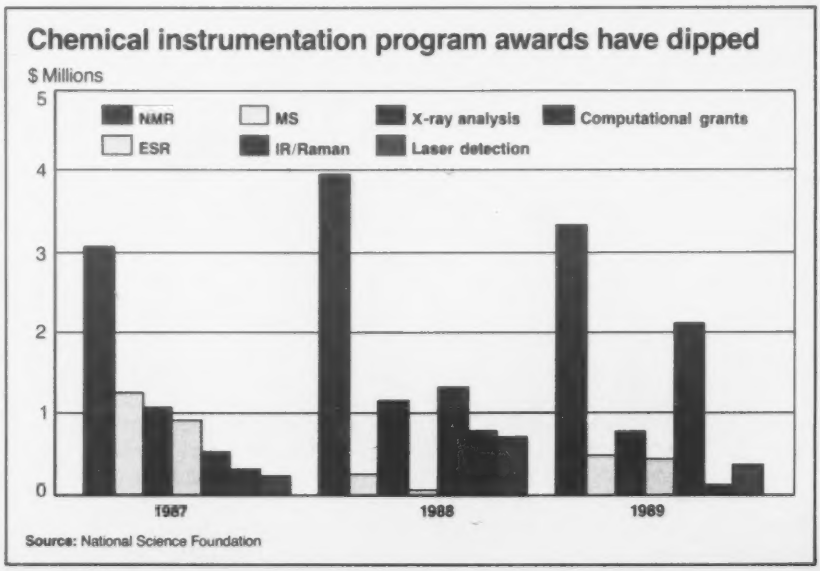
Most of the analytical instrumentation necessary to make this prognostication a reality is already available. The big challenge in the near future is solving the engineering problems of integrating all the various capabilities to come up with what Hoehn calls his "total answer."

Hoehn acknowledges that his "dream system" has some significant limitations. One is the sensitivity limit that is specific to hyphenated analytical systems, networked into data-handling systems. There may also be particular functional groups, classes of compounds, or even elements that can't be determined yet. And analytical probability limits of 99% may be insufficient in the future. Finally, it will be very expensive.

Though these limitations may slow development of the "dream system" or any lesser system, they don't alter the development trends. A key datum seems to be the MIPS (millions of instructions per second) costs for data processing. The MIPS costs have been declining rapidly. In the near future laboratory desktop computers capable of 50 to 100 MIPS likely will become available.

Industry will continue to include analytical costs in its prices to customers. Academe must acquire funds in other ways. Two of the principal funding sources for the academic community are the National Science Foundation (NSF) and the National Institutes of Health (NIH). Each has evolving programs to encourage academic research. Unhappily, the total funds awarded are always less than those requested.

One of NIH's programs is the Shared Instrument Grant (SIG) program, established in 1982. SIG is targeted on large-scale, specialized research instruments that can be shared by different groups and is designed to complement other funding programs. SIG is intended only for individual instruments with



U.S., Soviets discuss energy cooperation

HERMIES IIB robot at Oak Ridge National Lab is inspected by Soviet science officials (from left) Valeriy E. Anoshin, counselor, State Committee on Science & Technology; Aleksey N. Makukhin, first deputy minister of Energy & Electrification; and Vyacheslav M. Batenin, director, High Temperature Institute, Soviet Academy of Sciences. The trio was part of a nine-member high-level delegation that recently visited Washington, D.C., to discuss U.S.-Soviet cooperation in nonnuclear energy R&D and related trade opportunities, and toured Oak Ridge, the Department of Energy's Pittsburgh Energy Technology Center, and private-sector facilities. The two sides seek to renew an agreement signed in 1974, but let lapse by the U.S. in 1982 because of Soviet invasion of Afghanistan and the program's lack of benefit to the U.S. A DOE team will visit the U.S.S.R. in late March to continue talks.

price tags between $100,000 and $400,000. At least three users are required for 75% of the instrument's operating time.

In determining awards, SIG managers consider the extent to which an award would aid research already in progress or planned, how it would provide information not otherwise available, the presence of the expertise to operate and maintain the instrument, and the commitment of the institution to support the project and instrument.

In 1988, the largest number of requests were for NMR spectrometers (18%), gene machines (17%), electron microscopes (13%), and cell sorters (10%). These requests were received from institutions including health-professional schools, other graduate schools, hospitals, and research organizations. Foreign and private institutions are not eligible. More than 70% of the awards have been made to graduate and medical schools.

According to Marjorie A. Tingle, director of the Biomedical Research Support Program at NIH, SIG has received 1955 applications since its inception, with requests totaling $439 million. About 88% of the applications were approved and 77% of the dollars were recommended. Of the total applications, 1029 awards were made for $195 million.

The number of applications has increased 45% in the past two years. The 1989 budget was $105 million and Tingle doesn't expect it to increase. It may even drop, with a corresponding drop in awards. This is partially due to the emphasis on AIDS research that has the front row in funding at the present time.

Smaller grants are made by NSF's Chemical Instrumentation Program (CIP). Program director George M. Rubottom says the policy is for NSF to pick up two thirds of the acquisition cost for hardware, with the remaining one third being matching funds from elsewhere. Requesters can also apply for operations and maintenance grants of 10% of the instrument cost for up to five years, although the preferred payout period is 10% for three years.

NIH also considers requests for cofunding. If the cofunding institution is within NIH, the total request is jointly considered. This usually happens in the case of multidisciplinary research. For non-NIH cofunding sources the normal procedure of independent review is followed.

Rubottom says the success rate for proposals under CIP is about 50%. He expects this to decrease in the future mostly because the program is getting requests for more and larger instruments. In fiscal 1989, CIP allocated $8.4 million from a total budget of $98 million. Some of this went to regional facilities that will be phased out in the future.

However, a new program that promises to gain support is Instrumentation and Laboratory Improvement (ILI). This is for Ph.D.-granting schools that request funds to aid in education, that is, not for specific research activities. Rubottom expects the ILI program to be around for a long time because he notes, as have others, that education in analytical lab operation has lagged for years.

Most observers on the analytical scene touch on the matter of education. In general, they note that analytical labs are faced with a shortage of adequately trained personnel. No one contradicts this gloomy assessment. Few opportunities exist to train people to run an analytical lab. Instrument training is usually encountered in the normal course of instruction in progressive schools. It is often appended to regular courses, and not always well integrated into the curriculum. In industry, training often is part of an instrument-purchase package and, consequently, instrument specific. Updating the operating personnel is a perpetual problem and professional obsolescence is a growing problem. Continuous retraining is necessary.

One of the more unusual, possi-

bly unique, programs for training analytical chemists is operated by John P. Walters, professor of chemistry at St. Olaf's College in Northfield, Minn. Walters refers to his program as a 20-year experiment that started at the University of Wisconsin in 1969 and moved to St. Olaf's in 1982. The experiment attempts to integrate ethics, small group dynamics, management skills, and the traditional vocational skills in analytical chemistry without the usual compartmentalization. For want of a better name, Walters calls this role-playing.

Walters' system begins in the freshman and sophomore years by developing the computer as an information management tool. This has the added virtue of countering some of the negative views of science that some young people have. Analytical chemistry itself is introduced in the junior year. Role-playing is the central feature of the laboratory exercises. The classes are divided into four roles: managers responsible for organizing the experiment, chemists responsible for manipulating solutions, "software" responsible for data collection, and "hardware" responsible for instrument selection.

In the senior year the same four roles are given different emphasis. Managers become more involved in experiment design, chemists become more involved in preparing solutions, hardware becomes more involved in assembling instruments, and software is more involved in processing data. The program at St. Olaf's emphasizes interdependence between skilled individuals and the division of responsibility, as opposed to the division of labor.

Walters claims that role-playing adds realism to an often deadly-dull lab course that traditionally stressed individual competition. He also says that in the role-playing ambience, students can make mistakes without becoming demoralized. □

British science journals are being revamped

This year the Royal Society of London's scientific journals are undergoing their first major reorganization in many years, the intention being to interest a broader international audience and to attract a wider range of prospective authors.

The changes include new procedures for submitting papers to the physical and mathematical sciences journal *Proceedings of the Royal Society of London, Series A*. Previously, a researcher had to contact a fellow or foreign member of the Royal Society and persuade him or her to communicate the paper to a journal.

"Clearly, for authors residing outside the U.K., that was not always an easy or convenient thing to do," says Michael E. Fisher, a professor in the Institute for Physical Science & Technology at the University of

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